

# DETECTION OF NITROGEN NEEDS FOR DETERMINING THE AMOUNT OF FERTILIZERS IN RICE PLANTS BASED ON LEAVES COLOR USING SUPPORT VECTOR MACHINE

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## ABSTRACT

Nitrogen is one of the nutrients that plays an important role in the process of rice growth. To find out the need for nitrogen in rice can be seen from the color of the leaves. The greener the color of the leaves in rice, the higher the nitrogen content. Conversely, if the color of the leaves is yellowing, the nitrogen content will be lower. certain results in accuracy that is not good that is equal to 66.7%. Therefore this study uses a machine learning Support Vector Machine (SVM) as a classification of detection systems for rice nitrogen requirements based on leaf color. The purpose of this research is to implement the Support Vector Machine method in the detection of rice nitrogen requirements based on leaf color. From the results of accuracy testing, the accuracy of the system in analyzing and recommending nitrogen requirements on average is 79% and the best accuracy based on time is in the morning with an accuracy value of 88%. Based on these results, it was concluded that the SVM algorithm can be applied in the detection of rice nitrogen requirements based on leaf color.

**Keywords :** Rice, Nitrogen, Leaf Color Chart, SVM, Histogram.

## 1. PRELIMINARY

Nitrogen is one of the main elements in rice. Nitrogen is needed by plants for photosynthesis as a maker of leaf green or chlorophyll. The application of nitrogen fertilizer that is suitable with the needs of plants is the key in increasing plant growth to get optimal results [1]. Excessive application of nitrogen fertilizer can cause plants to turn green [2] so that these plants can be vulnerable to pests and diseases. Giving better nitrogen fertilizer can also be used for grain maturation, straw becomes easier and easier to fall and grain quality decreases [1]. While Nitrogen deficiency causes plant growth to be stunted, roots are limited, leaves become yellow due to lack of chlorophyll, biomass production decreases and grain tends to fall out easily [2].

Leaf Color Chart (BWD) is a useful tool for knowing the N nutrient levels of rice plants. In this tool there are four color scale boxes, ranging from light green to dark green, which are assessed on the

level of greenness of rice plants. Giving fertilizer based on the results of color measurements with a 4 scale BWD can use fertilizer 15-20% of the amount used by farmers without using the results [1]

Previous research on the detection of nitrograph requirements in rice was conducted in 2018 using the RGB Color Extraction, K-Nearest Neighbor (KNN) and Euclidean Distance [3] methods. In this study, the trial scenario was carried out with a total of 120 images of rice leaf samples taken through the camera, each color level tested with ten leaf images taken in the morning, afternoon and evening. From the results of tests that have been carried out the accuracy produced is still of moderate value, amounting to 66.7%. Subsequent research in 2018 has been carried out to determine the sweetness level of mangoes based on color features by implementing the Support Vector Machine and K-Nearest Neighbors (K-NN) methods producing an accuracy value of 87.5% for SVM and 83.3% for KNN so the accuracy of SVM is superior compared to KNN [4].

Based on previous exposure, this research uses the Support Vector Machine (SVM) method as a classification for detecting the need for nitrogen to determine the amount of rice fertilizer based on leaf color.

## 2. RESEARCH CONTENT

### 2.1 HSV Color Model

HSV is a better color model to be used for various purposes of image processing and computer vision. For example, the tracking object based on color, image segmentation, etc. Hue (H) is a measure of the type of color such as red, yellow, green and so on. Its representation is in the form of degrees with values 0 - 360. Saturation (S) is the color of a color. The more colorful a color means the greater the saturation value. But if a pale color, it means low saturation. Value (V) is the value of the brightness of a color. Bright colors have high values and vice versa for dark colors [5].

$$V_m = \min R, G, B \quad (1)$$

$$S = \begin{cases} 0 & \text{jika } V = 0 \\ \frac{V_m}{V} & \text{jika } V > 0 \end{cases} \quad (2)$$

$$H = \begin{cases} 0^\circ & \text{jika } S = 0 \\ 60^\circ \times \left(\frac{G-B}{V_m} \bmod 6\right) & \text{jika } V = R \\ 60^\circ \times \left(2 + \frac{B-R}{V_m}\right) & \text{jika } V = G \\ 60^\circ \times \left(4 + \frac{R-G}{V_m}\right) & \text{jika } V = B \end{cases} \quad (3)$$

## 2.2 Erode

Erode operations (erosion) have the effect of reducing the structure of the image. Erosion surgery can be formulated as follows [6]:

$$A \ominus B = \{p \in z^2 \mid (a+b) \in \text{, untuk setiap } b \in B\} \quad (4)$$

Where A is  $f(x, y)$  from the original image and B is a structural element or commonly called strel. The structural element commonly used in erosion operations is a box shape. There are other structural elements in the form of ellipse, line, disk and others.

The erosion result is usually the logical AND operation of each coordinate A and B. The following is the result of the operation of the dilate contained in Figure 1.

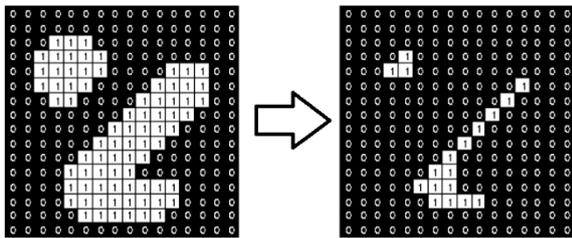


Figure 1. Erode Image Results

## 2.3 Dilate

Dilation operations (Dilation) are usually used to obtain the widening effect on pixels of value 1. Dilation operations can be formulated as follows [6]:

$$A \oplus B = \{z \mid z = a + b, \text{ dengan } a \in A \text{ dan } b \in B\} \quad (5)$$

Where A is  $f(x, y)$  from the original image and B is a structural element or commonly called strel. The structural elements commonly used in dilation operations are also usually box shaped. The results of the dilation are the sum of all coordinate pairs of A and B. The following is the result of the dilate operation shown in Figure 3.

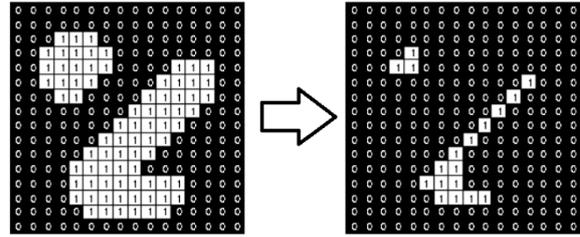


Figure 2. Hasil Gambar Dilate

## 2.4 Histogram Warna

The color histogram is the feature most widely used to represent the color features of an image. The image is generally converted into a certain color space, then each component of the color space is made histogram. HSV color space in general is often used because the color space is close to human perception. However, it would be better to choose the color space based on the object being faced [7]. Mathematically the image histogram is calculated by the formula:istogram warna merupakan fitur yang paling banyak digunakan untuk merepresentasikan ciri warna suatu citra. Citra pada umumnya dikonversi ke dalam suatu ruang warna tertentu, kemudian setiap komponen ruang warna dibuat histogramnya. Ruang warna HSV pada umumnya sering digunakan karena ruang warna tersebut dekat dengan persepsi manusia. Namun demikian akan lebih baik pemilihan ruang warna didasarkan pada objek yang dihadapi [7]. Secara matematis histogram citra dihitung dengan rumus :

$$h_i = \frac{n_i}{n}, \quad i = 0, 1, \dots, L-1 \quad (6)$$

which in this case,

$n_i$  = number of pixels that have gray degrees  $i$   
 $n$  = the total number of pixels in the image

## 2.5 Overall Image Intensity

In a histogram it can be seen the overall image intensity so that it can be concluded that the image is dark or bright. The luminosity of an image can be measured by calculating the mean value of the histogram according to the following equation:

$$\text{mean} = \sum_i \frac{H(i)}{N} \quad (7)$$

The higher the average value, the higher the brightness of an image

## 2.6 Image Contrast

Quantitatively, the contrast value of an image can be calculated based on its standard deviation by using the equation

$$\text{var} = \frac{\sum (i - \text{mean})^2 H(i)}{N} \quad (8)$$

$$\text{std} = \sqrt{\text{var}} \quad (9)$$

Table 1. The algorithm testing parameter

| Parameter           | Nilai            |
|---------------------|------------------|
| Maksimal Perulangan | 10, 50, 100      |
| Rasio Pembelajaran  | 0.1, 0.5, 1      |
| Minimal Error       | 0.1, 0.01, 0.001 |

## 2.7 Open CV

OpenCV (Open Source Computer Vision Library) is a software library intended for image processing that is commonly used in real-time (at that time). This library is made by Intel and is a library that is free to use and is in the shade of the open source (Open source) of the license. This library can also be used on various platforms and is dedicated mostly for real-time image processing [8]. Generally this library uses the C / C ++ programming language, but lately has been developed in various programming languages such as Python and Java.

## 2.8 Support Vector Machine

When SVM was first introduced by Vapnik, it could only classify data into two classes (binary classification). However, further research to develop SVM so that it can classify data that has more than two classes, continues to be done. There are two options for implementing an SVM multiclass by combining several binary SVMs or combining all data consisting of several classes into a form of optimization problem. Following are the commonly used methods to implement SVM multiclass with the following approaches [9]

### Metode one-against-all

Using this method, a binary SVM model will be built (k is the number of classes). For example, there are classification problems with 4 classes. For training, four binary SVMs are used as shown in Table 2 and users in classifying new classes can be seen in the following equation [10]:

$$\text{Kelas } x = (x_i, x) = \arg \max_{i=1..k} ((w^{(i)})^T \cdot \varphi(x) + b^{(i)}) \quad (10)$$

**Table 2.** Example 4 Binary SVM with the One-against-all method

| $y_1 = 1$ | $y_1 = -1$    | Hipotesis               |
|-----------|---------------|-------------------------|
| Kelas 1   | Bukan kelas 1 | $f^1(x) = (w^1)x + b^1$ |
| Kelas 2   | Bukan kelas 2 | $f^1(x) = (w^2)x + b^2$ |
| Kelas 3   | Bukan kelas 3 | $f^1(x) = (w^3)x + b^3$ |
| Kelas 4   | Bukan kelas 4 | $f^1(x) = (w^4)x + b^4$ |

## 2.9 Kernel Trick

Feature space in practice usually has a higher dimension than the input vector. This results in computing the feature space may be very large, because there is a possibility that feature space can have an unlimited number of features. In addition, it is difficult to know the exact transformation function. To overcome this problem, the "kernel trick" is used in SVM. Commonly used kernel functions are as follows [9]:

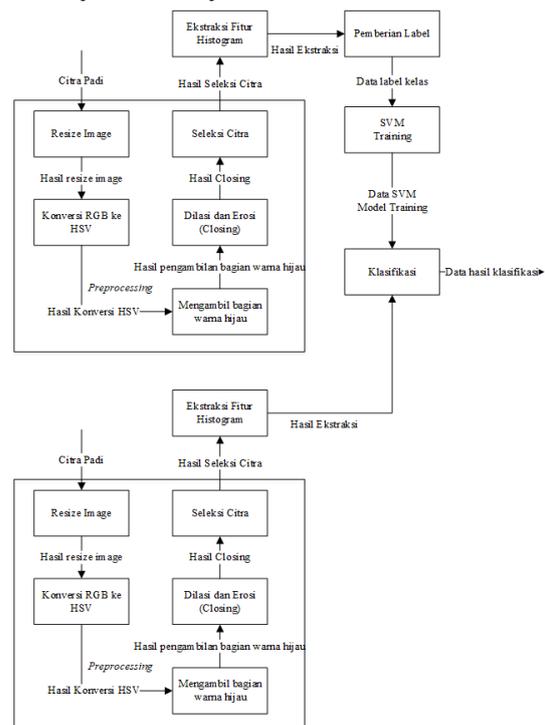
## RBF Kernel

$$K(x_i, x) = \exp(-\gamma |x_i - x|^2), \gamma > 0 \quad (11)$$

## 2.10 HSV Image Segmentation

Color segmentation based on HSV color detection is a controlled segmentation process with HSV color filters. The HSV color filter will separate certain colors according to the reference color and the tolerance value of each HSV color element. User control through color sample and color tolerance that becomes the reference filter so that segments can be obtained with the appropriate color. The results of color segmentation based on HSV color detection are strongly influenced by the color sample and the color tolerance value that is the reference for the segmentation process. Lighting, location, texture and contour of objects or background images will greatly affect the results of segmentation and object detection [10].

## 2.11 System Analysis

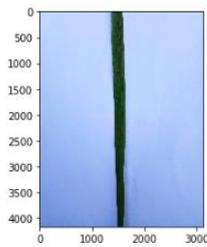


**Figure 3.** General description of the system

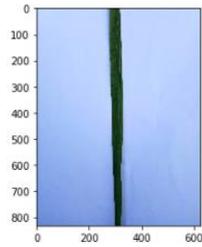
Explanation of the steps above is as follows:

### 1. Resize Image

For a faster process of finding parameters in the input data image, the initial input image will be resized by resizing the image from the original image size to an image size of 832 x 624 pixels with RGB color modes (Red, Green, Blue) which means that in each There are 3 pixel color values. Here are the original images (left) and resized images (right):



Gambar 4. Citra Asli



Gambar 5. Hasil Resize

2. Conversion RGB to HSV

The image that has been resized before is an RGB image (Red, Green, Blue). The process in this stage is changing the RGB value of each pixel image to the HSV image value. For example, take the RGB value at pixel (1,1), then the conversion calculation process RGB to HSV uses equation (1) as follows:

$$V = \max(184, 187, 196)$$

$$V = 196$$

$$S = \begin{cases} \frac{V_{\min}(R, G, B)}{V} & \text{jika } V \neq 0 \\ 0 & \text{jika } V = 0 \end{cases}$$

$$S = \frac{V_{\min}(184, 187, 196)}{196}$$

$$S = 0.06122449$$

$$H = 240 + 60 \frac{18 - 187}{- \min(184, 187, 196)}$$

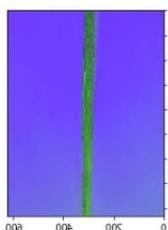
$$H = 225$$

Didapatkan nilai HSV dari pixel (1,1) yaitu H = 225, S = 0.06122449 dan V = 196.

Berikut hasil konversi dari RGB ke HSV



Gambar 6. Citra RGB



Gambar 7 Citra HSV

3. Taking part in green

In this process the color HSV will be taken only on the Green HSV and moved to another color for Leaf segmentation. This green HSV is based on a scale of green values. The following is a scale of the range of green HSV color values:

1. Hue values are in the range of values from 34 to 100
2. Saturation values range from 100 to 255
3. Value values range from 10 to 255

The following is a flowchart of finding HSV

the results of taking only the green HSV value are shown in Figure 3.6 as follows:

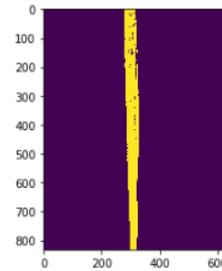


Figure 8. Results of taking HSV green

4. Dilation and erosion (closing)

In this process, closing will be done, which is doing image morphological operations where the image will go through the dilation stage first after which erosion will be carried out. Closing aims to fill small holes in objects, combining adjacent objects.

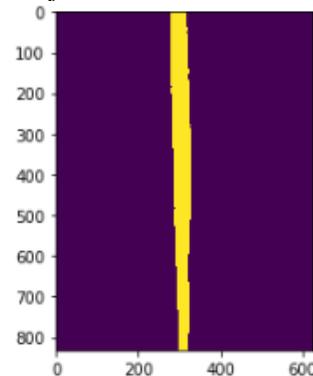


Figure 9. Closing Operation Result

5. Seleksi Citra

After obtaining the pattern, the Original image will be selected based on the result pattern from the previous closing process. The following flow chart for image selection is in the following image:

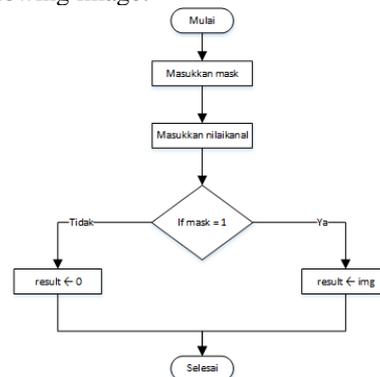
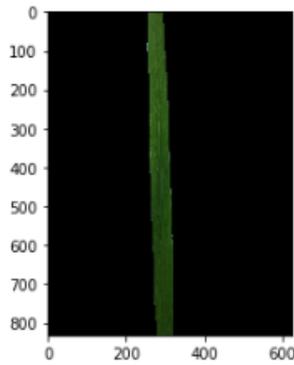


Figure 10. Flow Chart Seleksi Citra

The results of the image selection process are shown in Figure 11 below :



**Figure 11.** Selected image

6. Histogram Feature Extraction

In the next stage, feature extraction will be performed using the color histogram feature. The histogram method used is to take the values of luminosity (mean) and contrast (std) [7]. From the selected images, the following feature values are obtained:

$$\begin{aligned} \text{mean}_{\text{red}} &= 1.7475 & \text{std}_{\text{red}} &= 7.5822 \\ \text{mean}_{\text{green}} &= 3.6057 & \text{std}_{\text{green}} &= 14.6895 \\ \text{mean}_{\text{blue}} &= 1.875 & \text{std}_{\text{blue}} &= 8.0314 \end{aligned}$$

7. Giving Class Name

After the data has succeeded in getting the feature value then the image that has been obtained for the feature value can then be labeled and grade. Examples of labeling can be seen in Table.3.

**Table 3.** Pemberian kelas

| Histogram Feature  | Label | Kelas   |
|--|-------|---------|
| $\text{mean}_{\text{red}} = 1.7475$<br>$\text{mean}_{\text{green}} = 3.6057$<br>$\text{mean}_{\text{blue}} = 1.8758$<br>$\text{std}_{\text{red}} = 7.5822$<br>$\text{std}_{\text{green}} = 14.6895$<br>$\text{std}_{\text{blue}} = 8.0314$ | +1    | Level 2 |

8. SVM Training

To do the training, the data is taken and given the label and class as in the table

**Table 4.** Training data that has been labeled and class

| Fitur Histogram  | Label | Kelas   |
|--|-------|---------|
| $\text{mean R} = 3.274$<br>$\text{mean G} = 6.122$<br>$\text{mean B} = 1.8645$<br>$\text{std R} = 11.7782$<br>$\text{std G} = 21.441$<br>$\text{std B} = 7.6759$ | +1    | Level 2 |

|   |    |         |
|---|----|---------|
| $\text{mean R} = 1.7475$<br>$\text{mean G} = 3.6057$<br>$\text{mean B} = 1.8758$<br>$\text{std R} = 7.5822$<br>$\text{std G} = 14.6895$<br>$\text{std B} = 8.0314$  | -1 | Level 3 |
| $\text{mean R} = 3.1356$<br>$\text{mean G} = 6.138$<br>$\text{mean B} = 3.3455$<br>$\text{std R} = 10.7392$<br>$\text{std G} = 20.0358$<br>$\text{std B} = 11.9367$ | -1 | Level 4 |
| $\text{mean R} = 1.6592$<br>$\text{mean G} = 4.2026$<br>$\text{mean B} = 4.4214$<br>$\text{std R} = 6.5381$<br>$\text{std G} = 16.1857$<br>$\text{std B} = 16.9892$ | -1 | Level 5 |

Furthermore, each extracted image is named x1, x2, x3 and x4

**Table 5.** Data are x1, x2, x3 and x4

| Da ta          | Mea n R | Mea n G | Mea n B | Std R   | Std G   | Std B   |
|----------------|---------|---------|---------|---------|---------|---------|
| x <sub>1</sub> | 3.274   | 6.122   | 1.8645  | 11.7782 | 21.441  | 7.6759  |
| x <sub>2</sub> | 1.7475  | 3.6057  | 1.8758  | 7.5822  | 14.6895 | 8.0314  |
| x <sub>3</sub> | 3.1356  | 6.138   | 3.3455  | 10.7392 | 20.0358 | 11.9367 |
| x <sub>3</sub> | 1.6592  | 4.2026  | 4.4214  | 6.5381  | 16.1857 | 16.9892 |

Do the x-xi calculation. The results of these calculations can be seen in the table

**Table 6.** Hasil pengurangan x-x<sub>i</sub>

| Da ta lati h                    | Mean R | Mean G | Mean B | Std R  | Std G  | Std B  |
|---------------------------------|--------|--------|--------|--------|--------|--------|
| x <sub>1</sub> - x <sub>1</sub> | 0      | 0      | 0      | 0      | 0      | 0      |
| x <sub>1</sub> - x <sub>2</sub> | 1.5265 | 2.5163 | 0.0113 | 4.196  | 6.7515 | 0.3555 |
| x <sub>1</sub> - x <sub>3</sub> | 0.1384 | -0.016 | -1.481 | 1.039  | 1.4052 | 4.2608 |
| x <sub>1</sub> - x <sub>4</sub> | 1.6148 | 1.9194 | 2.5569 | 5.2401 | 5.2553 | 9.3133 |

Then do the operation to calculate the length of the vector with the following equation:

$$\| \mathbf{x} - \mathbf{x}_i \|$$

For Xi the calculation is as follows::

$$\| \mathbf{x}_1 - \mathbf{x}_1 \| =$$

$$\sqrt{\frac{0.0000^2 + 0.0000 + 0.0000^2 + 0.0000^2}{+0.0000^2 + 0.0000^2}} = 0.0000$$

Then we get the result for  $x_i = 0.0000$ , do the calculation for the next value of  $x_i$

Berikutnya panjang vektor kemudian dimasukan ke dalam persamaan  $\exp(-\gamma \|x - x_i\|^2)$  as follows:

$$\begin{aligned} K(1,1) &= \exp(-\gamma \|x_1 - x_1\|^2) \\ &= \exp(-0,1(0.0000^2)) \\ &= \exp(0) \\ &= 1 \end{aligned}$$

Do these calculations for the next value of  $x_i$ . So the results of the calculation of the K value with the RBF kernel are like in Table 7

**Table 7.** Calculation Result of K Value with RBF kernel

| K(1,1)   | K(1,2)   | K(1,3)   | K(1,4)   |
|----------|----------|----------|----------|
| 1        | 0.000748 | 0.096123 | 1.92E-07 |
| K(2,1)   | K(2,2)   | K(2,3)   | K(2,4)   |
| 0.000748 | 1        | 0.001612 | 0.000118 |
| K(3,1)   | K(3,2)   | K(3,3)   | K(3,4)   |
| 0.096123 | 0.001612 | 1        | 0.001491 |
| K(4,1)   | K(4,2)   | K(4,3)   | K(4,4)   |
| 1.92E-07 | 0.000118 | 0.001491 | 1        |

Then the next step is to calculate  $y$ . For the value of  $y$  is the value of the label. The value of  $y$  can be seen in Table 8.

**Table 8.** Label value on  $y$

| $y_1$ | $y_2$ | $y_3$ | $y_4$ |
|-------|-------|-------|-------|
| 1     | -1    | -1    | -1    |

Then the calculation is done as much as N data. The results of these calculations can be seen in Table 9

**Table 9.** Calculation  $y_i y_j$

| $y_1 y_1$ | $y_1 y_2$ | $y_1 y_3$ | $y_1 y_4$ |
|-----------|-----------|-----------|-----------|
| 1         | -1        | -1        | -1        |
| $y_2 y_1$ | $y_2 y_2$ | $y_2 y_3$ | $y_2 y_4$ |
| -1        | 1         | 1         | 1         |
| $y_3 y_1$ | $y_3 y_2$ | $y_3 y_3$ | $y_3 y_4$ |
| -1        | 1         | 1         | 1         |
| $y_4 y_3$ | $y_4 y_3$ | $y_4 y_3$ | $y_4 y_4$ |
| -1        | 1         | 1         | 1         |

By using K kernel instead of dot-product  $i j$  in the Lagrange multiplier duality equation is obtained

$$\begin{aligned} Ld \max &= (a_1 + a_2 + a_3 + a_4) - \\ &\frac{1}{2} (a_1^2 - 0.001496513 a_1 a_2 - 0.19224543 a_1 a_3 - \\ &(3.84534E - 07 a_1 a_4) + a_2^2 + \\ &0.003224797 a_2 a_3 + 0.000236784 a_2 a_4 + a_3^2 + \\ &0.002981918 a_3 a_4 - a_4^2) \end{aligned}$$

$$\begin{aligned} \text{Syarat 1 : } &a_1 - a_2 - a_3 - a_4 = 0 \\ \text{Syarat 2 : } &a_1, a_2, a_3, a_4 \geq 0 \end{aligned}$$

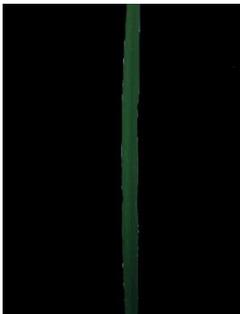
In the objective function, the second term has been multiplied by  $y_i y_j$ . The equation meets the standard Quadratic Programming so that it can be helped to solve it with a commercial solver for Quadratic Programming (QP). With the help of software, the following results were obtained..

$$\begin{aligned} a_1 &= 1.499994078 \\ a_2 &= 0.499998026 \\ a_3 &= 0.49998982 \\ a_4 &= 0.499998026 \\ b &= -0.499985873 \end{aligned}$$

#### 9. Classification (SVM Testing)

After successfully performing the training calculation, the SVM Testing calculation is then performed with the sample data being sampled as shown in Table 10.

**Table 10.** Testing Data

| Citra data testing   | Fitur Histogram  |
|--|--|
|  | Mean R = 2.0813<br>Mean G = 4.5282<br>Mean B = 2.2206<br>Std R = 7.9187<br>Std G = 16.4213<br>Std B = 8.7611 |

Do operation  $x_{training_i} - x_{testing}$ . The results of these calculations can be seen in Table 11

**Table 11.** Tabel Data Testing

| Data                                  | Mea n R         | Mea n G         | Mea n B         | Std R           | Std G           | Std B           |
|---------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| $x_{train_i}$ ng1-<br>$x_{testin}$ g  | 1.19<br>27      | 1.59<br>38      | 0.35<br>61      | 3.85<br>95      | 5.01<br>97      | 1.08<br>52      |
| $x_{train_i}$ ng2 -<br>$x_{testin}$ g | -<br>0.33<br>38 | -<br>0.92<br>25 | -<br>0.34<br>48 | -<br>0.33<br>65 | -<br>1.73<br>18 | -<br>0.72<br>97 |

|                 |      |      |      |      |      |      |
|-----------------|------|------|------|------|------|------|
| $x_{training3}$ | 1.05 | 1.60 | 1.12 | 2.82 | 3.61 | 3.17 |
| $x_{testing3}$  | 43   | 98   | 49   | 05   | 45   | 56   |
| $x_{training4}$ | -    | -    | -    | -    | -    | -    |
| $x_{testing4}$  | 0.42 | 0.32 | 2.20 | 1.38 | 0.23 | 8.22 |
| $x_{testing4}$  | 21   | 56   | 08   | 06   | 56   | 81   |

Next do the calculation for the vector

$$\|x_{trainingi} - x_{testingi}\|$$

So we get the value of the vector length as in Table 11

**Table 11.** Vector Length Results

|                                    |             |
|------------------------------------|-------------|
| $\ x_{training1} - x_{testing1}\ $ | 6.7350      |
| $\ x_{training2} - x_{testing2}\ $ | 2.1739      |
| $\ x_{training3} - x_{testing3}\ $ | 6.006052814 |
| $\ x_{training4} - x_{testing4}\ $ | 8.648173087 |

$$K(x_{training1}, x_{testing1}) = \exp(-\gamma \|x_{training1} - x_{testing1}\|^2) = \exp(-0,5(6.735007522)^2) = 0.010715836$$

Do the calculation for  $x_{training}$  2,3 dan 4

$$f(x_{testinglevel2}) = (((1.499994078 * 1 * (0.010715836)) + (0.499998036 * (-1) * 0.633370564) + (0.499998982 * (-1) * (0.02712588)) + (0.499998036 * (-1) * (0.000514771))) + (-0.499985873)) = -0.809441282$$

$$\max(f(x_{testing})) = [(-0.809441282)(0.443548388) (-0.152737512)(-0.179254946)]$$

Based on maximum value  $f(x_{testing})$ , the result of the multiclass classification is that the test data are part of level 3 class.

### 2.7 Confusion Matrix Testing

Accuracy testing using confusion matrix is performed to test the performance of the rice nitrogen demand detection application. The accuracy testing was made into three times according to the image taken as a dataset, namely morning, afternoon and evening.

Scenario 1 : 60 *training* data and 60 *testing* data

**Table 12.** Accuration Result From Skenario 1

| Accuracy  |         |         |         |         |      |
|-----------|---------|---------|---------|---------|------|
| Time      | Level 2 | Level 3 | Level 4 | Level 5 | Mean |
| Morning   | 85%     | 60%     | 60%     | 75%     | 83%  |
| Afternoon | 55%     | 70%     | 75%     | 100%    | 70%  |
| Evening   | 80%     | 65%     | 67%     | 92%     | 75%  |
| All       | 100%    | 65%     | 65%     | 100%    | 76%  |

Scenario 2 : 72 *training* data and 48 *testing* data

**Table 13.** Accuration Result From Scenario 2

| Accuracy |         |         |         |         |      |
|----------|---------|---------|---------|---------|------|
| Waktu    | Level 2 | Level 3 | Level 4 | Level 5 | Mean |
| Pagi     | 100%    | 75%     | 75%     | 100%    | 88%  |
| Siang    | 81%     | 69%     | 63%     | 75%     | 72%  |
| Sore     | 50%     | 75%     | 69%     | 94%     | 72%  |
| All      | 77%     | 73%     | 69%     | 90%     | 77%  |

Scenario 3 : 84 *training* data and 36 *testing* data

**Table 13.** Accuration Result From Scenario 3

| Accuracy  |         |         |         |         |      |
|-----------|---------|---------|---------|---------|------|
| Time      | Level 2 | Level 3 | Level 4 | Level 5 | Mean |
| Morning   | 100%    | 75%     | 75%     | 100%    | 88%  |
| Afternoon | 75%     | 83%     | 58%     | 83%     | 75%  |
| Evening   | 50%     | 75%     | 69%     | 94%     | 72%  |
| All       | 75%     | 81%     | 67%     | 94%     | 79%  |

From the 3 test scenarios it is known that the highest overall accuracy is in testing scenario 3 by using 84 training data and 36 testing data with an accuracy value of 79% while from the 3 test scenarios the images taken in the morning always have the highest accuracy value of 88 % this is because the light intensity in the morning is not too high so the resulting color is clearer.

## 3. CLOSING

### 3.1 Conclusion

Based on the results of tests conducted, the following conclusions can be drawn. Overall, the greatest accuracy obtained from the implementation of SVM on the detection of rice nitrogen requirements is 79%, while based on the best time to take pictures is in the morning with an accuracy obtained of 88%. The factors that influence it are light. In the morning the light intensity is not too high so the resulting color looks more clear.

### 3.2 Suggestion

Besides the advantages - advantages of a system will certainly have shortcomings, therefore further development of this research are suggestions that can be given as follows::

1. Data addition was made with a more varied image acquisition, both in terms of size, image resolution, camera type, and other technical aspects of acquisition so that the data used could handle various test data..

2. To obtain more precise training data, it is better that at the time of image data acquisition it is always accompanied by competent researchers and pay attention to the quality of rice leaves to be selected.

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